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The Fourth Heart Sound

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Definition

The fourth heart sound is a low-pitched sound coincident with late diastolic filling of the ventricle due to atrial contraction. It thus occurs shortly before the first heart sound. Although it is also called the *atrial sound*, and its production requires an effective atrial contraction, the fourth heart sound is the result of vibrations generated within the ventricle. Commonly, its presence indicates increased resistance to filling of the left or right ventricle because of a reduction in ventricular wall compliance, and it is accompanied by a disproportionate rise in ventricular end-diastolic pressure. In patients with a fourth heart sound, its palpable correlate is often present: a concomitant brief presystolic outward movement of the chest wall.

Technique

The fourth heart sound can be detected occasionally by inspection, commonly by palpation and auscultation, and it can be depicted graphically by phonocardiographic recording. The evaluation of a fourth heart sound arising from the left ventricle is most readily carried out with the patient in the left lateral recumbent position. Inspection and palpation are employed first to identify the apex impulse, where the fourth heart sound is usually most prominent. These techniques are not used just to identify a site for careful auscultation. Instead, they often permit detection of the fourth heart sound's palpable and visible correlates, which reflect late diastolic (presystolic) left ventricular motion. As described later in this chapter, the presence of a palpable fourth heart sound greatly enhances its clinical significance. The presystolic outward movement of the cardiac apex is felt by the lightly applied fingers or hand. When visible, its appearance can be enhanced by shining a light tangentially over the cardiac apex or by taping the end of a small stick at the apical area.

Because the fourth heart sound is low in frequency, it is best heard with the bell of the stethoscope placed lightly against the chest wall. Though often soft and most prominent at the cardiac apex, the left ventricular fourth heart sound can be of sufficient intensity to be heard over other precordial areas. The fourth heart sound typically has a dull or thudding quality, and it can be suppressed by applying firm pressure on the stethoscope bell. This latter characteristic can be an aid in distinguishing a fourth heart sound from a split first heart sound, which is of higher frequency and more readily heard with the firmly applied bell or with the diaphragm of the stethoscope. The distinction can be made further by the fact that a split first heart sound is generally detected more widely over the precordium and remains well heard after the patient assumes the sitting or standing position. Maneuvers that heighten resistance to left ventricular ejection (e.g., isometric hand grip

exercise) typically enhance the intensity of left-sided fourth heart sounds.

A fourth heart sound arising from the right ventricle is best heard with the bell of the stethoscope placed at the lower left sternal border or subxiphoid area. As with other sounds arising from the right side of the heart, the intensity of the sound may be transiently increased during inspiration as a consequence of enhanced right atrial filling. Often, a right ventricular fourth heart sound is accompanied by a prominent "a" wave in the jugular venous pulse.

In concert with the first and second heart sounds, a pathologic fourth heart sound yields a characteristic auscultatory cadence that resembles the canter of a horse, hence the designation by some of the pathologic fourth heart sound as an *atrial gallop* (actually a misnomer since the sound originates in the ventricle). During rapid heart rates, during which diastole is foreshortened, it may be difficult or impossible to distinguish a fourth heart sound gallop from a third heart sound gallop occurring during the rapid filling phase. Moreover, when *both* third and fourth heart sounds are present during sinus tachycardia, their near-simultaneous occurrence can result in a loud, single summation gallop. In patients with tachycardia, carotid sinus massage (assuming no contraindication to its use) may permit the distinction of third from fourth heart gallop sounds by transiently slowing the heart rate.

Basic Science

During sinus rhythm, there are two phases of diastolic filling of the ventricles. The first, or rapid filling phase, occurs passively upon opening of the atrioventricular valves. The second occurs in late ventricular diastole as a result of atrial contraction. It is with this latter active phase of ventricular filling that the fourth heart sound is associated. Although the mandatory relationship of the fourth heart sound with vigorous atrial contraction has been recognized for over a hundred years, the mechanism of the sound's production is not established. It is clear that the sound arises from low-frequency (20 to 30 Hz) vibrations generated within the ventricle, produced, it has been proposed, by the sudden deceleration of active blood flow by the ventricular wall. It follows that conditions leading to increased stiffness of the ventricular wall (and, hence, greater ventricular resistance to inflow) will favor the development of the fourth heart sound. Indeed, reduced ventricular compliance such as occurs, for example, with left ventricular hypertrophy or ischemia, is the most important clinical implication of a pathologic fourth heart sound. In this setting, the delivery of the atrial component of filling to the nondistensible ventricle results in abnormally increased left ventricular end-diastolic pressure. However, this elevation of diastolic pressure is confined to late diastole (large presystolic wave of the ventricular pressure curve). This is a function of the

reduced ventricular compliance and does not necessarily imply reduced systolic function of the ventricle or cardiac failure. The delivery of the atrial component of filling to the noncompliant ventricle leads also to enhanced presystolic left ventricular motion, which may be reflected by palpable presystolic movement of the precordium, and by increased amplitude of the "a" wave as recorded graphically on an apex cardiogram. In patients with normally compliant ventricles, the presystolic ventricular motion accompanying atrial contraction cannot generally be felt at the bedside.

Since genesis of a fourth heart sound requires an effective atrial contraction, it does not occur in patients with atrial fibrillation. Also required for the production of a fourth heart sound is the relatively free flow of blood through the atrioventricular valve. Thus, a left- or a right-sided fourth heart sound does not occur in patients with advanced mitral or tricuspid stenosis, respectively.

Clinical Significance

The significance of most physical findings must be assessed in the context in which they occur. This is particularly true for the fourth heart sound, as there is considerable controversy about its prevalence in older individuals with no clinically apparent cardiovascular disease. Many renowned clinicians classically considered the fourth heart sound to be an unequivocally abnormal finding in patients of any age. Others, particularly during the past decade, have provided data supporting the common presence of a fourth heart sound in healthy individuals age 50 or more years. Some have proposed that the greater prevalence of fourth heart sounds in otherwise normal older individuals may reflect a physiologic decrease in ventricular compliance with aging. The issue is clouded further by the finding in some blinded clinical trials of considerable disagreement among experienced examiners about the presence or absence of an audible fourth heart sound in individual subjects. The controversy about the clinical significance of the fourth heart sound may be the result, in part, of the diligence with which the sound has been sought (i.e., its intensity) and from the distinction of audible versus phonocardiographically recordable fourth heart sounds, as the latter can clearly be found in many normal older people. Thus, in the bedside assessment of an individual patient, the clinician must consider the patient's age, the presence or absence of other abnormal signs, and the intensity of the fourth heart sound. The clinical significance of an audible fourth heart sound is greatly strengthened by the presence of concomitant palpable presystolic precordial movement (palpable fourth heart sound). A prominent audible and palpable fourth heart sound is almost always an abnormal finding.

As described in the Basic Science section, a pathologic fourth heart sound usually indicates reduced ventricular compliance. Commonly, this results from conditions that can lead to ventricular hypertrophy. A left-sided fourth heart sound is frequently present in patients with systemic hypertension, aortic stenosis, or hypertrophic cardiomyopathy. A left ventricular fourth heart sound is common also in patients with coronary heart disease. Here, the decrease in ventricular compliance can be the result of prior myocardial infarction or acute ischemia. The fourth heart sound may become evident, or its intensity may be augmented, during episodes of angina pectoris. A fourth heart sound is an almost universal finding during the early stages of acute myocardial infarction if the patient has sinus rhythm. A fourth heart sound can occur with or without signs of heart failure. It does not per se indicate cardiac decompensation.

Right ventricular fourth heart sounds occur in clinical situations in which the compliance of that chamber is reduced. Hence, significant pulmonic valve stenosis and pulmonary arterial hypertension are typically accompanied by a right ventricular fourth heart sound.

A fourth heart sound does not always indicate reduced ventricular compliance. A fourth heart sound can also result when filling of a nondilated, normally compliant ventricle is markedly enhanced, as in some patients with anemia or thyrotoxicosis, and in those with acute mitral regurgitation. Prolongation of atrioventricular conduction can also promote the presence of audible fourth heart sound, as the results of atrial contraction are more temporally separated and distinct from the first heart sound.

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